

## T15D12 – Entropy IB Practice

Name.....

1. Which reaction causes a decrease in the entropy of the system?

- A.  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- B.  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
- C.  $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g})$
- D.  $2\text{SO}_3(\text{g}) \rightarrow 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$

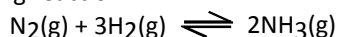
2. Which equation represents a change with a negative value for  $\Delta S$ ?

- A.  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$
- B.  $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{g})$
- C.  $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
- D.  $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$

3. Which reaction has the greatest positive entropy change?

- A.  $\text{CH}_4(\text{g}) + 1\frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- B.  $\text{CH}_4(\text{g}) + 1\frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- C.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- D.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

4. Consider the following reaction:



- (i) Suggest why this reaction is important for humanity. (next unit)

(1)

- (ii) Using the average bond enthalpy values in Table 10 of the Data Booklet, calculate the standard enthalpy change for this reaction.

(4)

- (iii) The absolute entropy values,  $S$ , at 238 K for  $\text{N}_2(\text{g})$ ,  $\text{H}_2(\text{g})$  and  $\text{NH}_3(\text{g})$  are 192, 131 and 193  $\text{J K}^{-1} \text{mol}^{-1}$  respectively. Calculate  $\Delta S^\ominus$  for the reaction and explain the sign of  $\Delta S^\ominus$ .

(2)

- (iv) Calculate  $\Delta G^\ominus$  for the reaction at 238 K. State and explain whether the reaction is spontaneous.

(3)

- (v) If ammonia was produced as a liquid and not as a gas, state and explain the effect this would have on the value of  $\Delta H^\ominus$  for the reaction.

(2)

(Total 12 marks)

5. Hex-1-ene gas,  $C_6H_{12}$ , burns in oxygen to produce carbon dioxide and water vapor.

(a) Write an equation to represent this reaction.

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(1)

(b) Use the data below to calculate the values of  $\Delta H_c^\ominus$  and  $\Delta S_c^\ominus$  for the combustion of hex-1-ene.

Substance	$O_2(g)$	$C_6H_{12}(g)$	$CO_2(g)$	$H_2O(g)$
Standard enthalpy of formation, $\Delta H_f^\ominus / \text{kJ}^{-1} \text{mol}^{-1}$	0.0	-43	-394	-242
Entropy, $S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$	205	385	214	189

(i) Value of  $\Delta H_c^\ominus$

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(2)

(ii) Value of  $\Delta S_c^\ominus$

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(2)

(c) Calculate the standard free energy change for the combustion of hex-1-ene.

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(2)

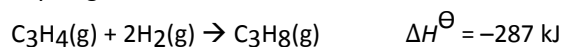
(d) State and explain whether or not the combustion of hex-1-ene is spontaneous at 25°C.

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(1)

(Total 8 marks)

6. (a) Propyne reacts with hydrogen as follows:



Calculate the standard entropy change of this reaction, given the following additional information:

$$S^\ominus \text{ of } H_2(g) = 131 \text{ J K}^{-1} \text{mol}^{-1}$$

(3)

(b) Calculate the standard free energy change at 298 K,  $\Delta G^\ominus$ , for the reaction in part (a). Use your answer and relevant information from part (d). If you did not obtain an answer to part (a), use  $\Delta S^\ominus = -360 \text{ J K}^{-1}$  (this is not the correct value).

(3)

(Total 6 marks)